SPECIFICATION AMENDMENTS

Amend the paragraph beginning in line 22 on page 1 as follows:

Sagnac interferometer comprising an optical fiber coil is being investigated and developed for its use in a current sensor which is free from influences of electrical noises and which does not require a dielectric strength to be secured. Sagnac interferometer comprising an optical fiber coil has been used in the art of detecting the rotation of a moving body in an optical fiber gyro application. In addition to detecting the rotation, Sagnac interferometer exhibits a response to a magnetic field generated by a current and such response can be utilized to determine a current. Specifically, when a magnetic field is applied to an optical fiber coil which comprises a transparent material, the Faraday effect causes a rotation of a polarization plane, and an angle of rotation of the polarization plane is proportional to both the strength of the magnetic field and a distance through which a light passes in the magnetic field. A phase difference is produced between dextrorotatory and levorotatory light passing through the optical fiber coil due to a rotation of the polarization plane. The detection of the phase differences allows the magnitude of the current which generated the magnetic field to be determined. A conventional example of a current sensor using a ~~sagnac~~ Sagnac interferometer will now be described with reference to Fig. 1.

Amend four paragraphs beginning in line 7 on page 4 as follows:

As mentioned above, a current sensor using a ~~sagnac~~ Sagnac interferometer determines the magnitude of a current which generated a magnetic field applied to a current sensing coil, by causing circularly polarized lights to impinge on opposite ends of the coils and propagate therethrough as a levorotatory light and a dextrorotatory light and causing the both lights having a phase difference therebetween to interfere with each other so that the resulting interfered light has a varying optical strength which can be used to determine the magnitude of the current.

In order for Sagnac interferometer to operate as a current sensor, it is necessary that circularly polarized lights be incident on the current sensing coil 6 as mentioned above. To satisfy this requirement, in the conventional example shown in Fig. 1, optical fibers or fiber portions shown in thick lines are constructed by polarization maintaining optical fibers. Specifically, except for the optical fiber which forms the current sensing coil 6, an optical fiber extending from the light source 1 to the first optical branch unit 2 and having a length on the order of one meter, an optical fiber extending from the first branch unit 2 to the first polarization filter 3 and having a length on the order of one meter, an optical fiber extending from the first polarization filter 3 to the second optical branch unit 4 and having a length on the order of one meter, and an optical fiber extending from the second optical branch unit 4 to the phase modulator 5 and having a length on the order of one meter are each formed by a polarization maintaining optical fiber. Assuming a total length of the optical fiber which forms the current sensing coil 6 to be ten meters, the length of each of optical fibers extending from the second optical branch unit 4 to the first quarter-wave plate 16 and extending from the second optical branch unit 4 to the second quarter-wave plate 17 has a length which is chosen to be about fifty meters, each optical fiber of such length being formed by a polarization ~~sustaining~~ maintaining optical fiber. In the conventional example shown, the first optical branch unit 2, the first polarization filter 3, and the second optical branch unit 4 are also formed by polarization maintaining optical fibers, as shown.

It is to be understood that a considerable length of time is required for the alignment of the proper axis of light from the light source 1 with the proper axis of a polarization ~~sustaining~~ maintaining optical fiber which connects to the first optical branch unit 2, and accordingly, this current sensor is correspondingly expensive. In addition, a polarization maintaining optical fiber is much more expensive than a singlemode optical fiber which does not maintain polarization. For this reason, the conventional current sensor of Sagnac interferometer type shown in Fig.1 is expensive.

Fig. 2 shows a current sensor using a ~~sagnac~~ Sagnac interferometer including a coil of length adjusting optical fiber added to the conventional example shown in Fig. 1.

Amend two paragraphs beginning in line 24 on page 6 as follows:

In the current sensor of Sagnac interferometer type shown in Fig. 2, except for the current sensing coil 6 which is to be formed by a single mode optical fiber, optical elements as well as optical fibers which connect between optical elements are formed by polarization maintaining optical fibers indicated by thick lines, and the length adjusting optical fiber coil 60 which is as long as ninety meters is also formed by a polarization ~~sustaining~~ maintaining optical fiber. This explains for an expensive price of the entire current sensor of Sagnac interferometer type.

It is an object of the present invention to provide a current sensor using a ~~sagnac~~ Sagnac interferometer which overcomes described problems caused by the use of polarization maintaining optical fibers.

Amend two paragraphs beginning in line 5 on page 12 as follows:

Non-polarized light refers to a light satisfying the requirements that an amount of light is equal between orthogonal modes and that the light between the orthogonal modes is incoherent. Light which satisfy these requirements is obtained by passage through a depolarizer. A depolarizer comprises a polarization ~~sustaining~~ maintaining optical fiber 21 having a length L1 and a polarization ~~sustaining~~ maintaining optical fiber 22 having a length L2, which have their one end faces cemented together, as shown in Fig. 4, for example. The ratio between the lengths L1 and L2 is chosen to be 1:2, and the both polarization maintaining optical fibers 21 and 22 are fused together so that their proper axes x, y are offset by 45°from each other. A depolarizer constructed in this manner is referred to as Lyot depolarizer having a unit length L_u which is normally chosen so that a group delay time difference between orthogonal components as the light propagates along the pair of proper axes x, y of a polarization ~~sustaining~~ maintaining optical fiber is equal to or greater than coherent time of light (For detail, see Journal of Lightwave Technology, Vol. LT1, No. 1, March 1983, pp. 71-74.).

A ratio between the lengths L1 and L2 of a polarization ~~sustaining~~ maintaining optical fiber is intended to provide a ratio in the group delay time difference between orthogonal

components in a Lyot depolarizer. It is then assumed that a group delay time difference between orthogonal components which occur in the first depolarizer 11, the second depolarizer 12 and the third depolarizer 13 is greater than the coherent time of light, and that the group delay time difference between the orthogonal components which occur in the first depolarizer 11, the second depolarizer 12 and the third depolarizer 13 are in the ration of 1:2:4, for example. It is assumed that each polarization ~~sustaining~~ maintaining optical fiber has an equal beat length. A group delay time difference between the proper axes x and y of a single depolarizer is equal to or greater than the coherent time of light, and the light which is converted into non-polarized light may have its plane of polarization rotated during its propagation through a single mode optical fiber, with consequence that while the component for the proper axis y, for example, has been lagging in the first depolarizer, the same component may be incident as x-component on the next depolarizer. In such instance, the light which has passed the next depolarizer may have its group delay time difference between the orthogonal components which may be equal to or less than the coherent time of light, thus failing to satisfy the requirement of non-polarization. If the group delay time difference of the next depolarizer is chosen to be twice that for the first depolarizer, it can be assured even in such instance that upon passage through the next depolarizer, the group delay time difference between the orthogonal components of the light is equal to or greater than the coherent time of light, thus assuring non-polarization.

Amend the paragraph beginning in line 23 on page 13 as follows:

A unit length for the first depolarizer 11or Lyot depolarizer is chosen to be 20cm (ratio 1). A usual polarization ~~sustaining~~ maintaining optical fiber has a beat length on the order of 2mm, and assuming the coherent time of light used on the order of 1.6×10^{-13} second, the group delay time difference between the orthogonal components during the propagation through a polarization ~~sustaining~~ maintaining optical fiber having a length of 20cm will be 2.7×10^{-13}, which is equal to or greater than the coherent time. It will be noted that this represents a coherent time for super-luminescent diode light source which is commonly used in an optical fiber gyro.

Amend the paragraph beginning in line 8 on page 14 as follows:

When such choice is made, the first depolarizer 11, the second depolarizer 12 and the third depolarizer 13 can be formed by polarization maintaining optical fibers while maintaining the group delay time difference between the orthogonal components resulting from the passage through the polarization ~~sustaining~~ maintaining optical fiber to be greater than the coherent time of light, and when the ratio of the group delay time differences between the orthogonal components of the first, the second and the third depolarizer 11, 12 and 13 is a ratio of 1:2:4 or 1:4:2 or greater, both the levo- and the dextro-rotatory light can be propagated through the optical path while remaining to be non-polarized and can be synthesized to suppress an error in the null-point drift due to polarized components.

Amend three paragraphs beginning in line 11 on page 16 as follows:

It will be seen from the foregoing that a current sensor using a ~~sagnac~~ Sagnac interferometer can be inexpensively provided as a whole while assuring a proper operation, by using the inexpensive single mode optical fibers for every optical path which connects between optical elements, providing the first depolarizer 11 between the first optical branch unit 2 and the first polarization filter 3, and providing combinations of depolarizer, polarization filter and quarter-wave plate on either end of the current sensing coil 6 to assure that any change in the plane of polarization which may have occurred may be returned to the given plane of polarization.

In an embodiment shown in Fig. 5, an optical fiber which connects between a light source 1 and a first optical branch unit 2 is formed by an inexpensive single mode optical fiber, the first optical branch unit 2 is formed by an inexpensive single mode optical fiber, and a first depolarizer 11 is connected between the first optical branch unit 2 and the first polarization filter 3. However, rather than providing a combination of a second depolarizer 12 and a second polarization filter 14 or a combination of a third depolarizer 13 and a third polarization filter 15 as in the embodiment shown in Fig. 3, each optical element and optical fiber which are located on a path from the second optical branch unit 4 to a first

quarter-wave plate 16 and a second quarter-wave plate 17 is formed by a polarization ~~sustaining~~ maintaining optical fiber as in the conventional example shown in Fig. 1. In this embodiment, there is no assurance that the plane of polarization of light be preserved from the light source 1 to the first depolarizer 11, but the connection of the first depolarizer 11 between the first optical branch unit 2 and the first polarization filter 3 assures that non-polarized light is obtained, and this non-polarized light is caused to impinge on the first polarization filter 3 and is then carried on by a polarization ~~sustaining~~ maintaining optical fiber to impinge on the first quarter-wave plate 16 and the second quarter-wave plate 17 as a properly linearly polarized light.

In this embodiment, the light source 1 such as light emission diode (LED) which emits non-polarized light may be used, whereby the troublesome alignment between the proper axes of light from the light source 1 and the proper axes of the polarization ~~sustaining~~ maintaining optical fiber can be conveniently dispensed with.

Amend the paragraph beginning in line 27 on page 17 as follows:

In the embodiments shown in Figs. 3 and 5, a length adjusting optical fiber coil as shown in Fig. 2 may also be used. In this instance, a single mode optical fiber is used in the former while a polarization ~~sustaining~~ maintaining optical fiber is used in the latter to provide the length adjusting optical fiber coil.

Amend the paragraph beginning in line 10 on page 19 as follows:

Accordingly, in the embodiment shown in Fig. 6, the intended purpose can be served by providing an arrangement such that a phase difference due to the Sagnac effect among the three coils, namely, the current sensing coil 6, the counter-clockwise length adjusting optical fiber coil 71 and the clockwise length adjusting optical fiber coil 72 be minimized as a whole. At this end, the coils 6, 71 and 72 are disposed so that their center axes are substantially aligned with each other, and the overall phase difference due to the Sagnac

effect which result from a rotation of the current sensing coil 6, the optical fiber coil 71 and the optical fiber coil 72 can be minimized by satisfying the following requirement:

~~$|R_e \times L_e + R_1 \times L_1 - R_2 \times L_2| < 5$~~

$|R_c \times L_c + R_1 \times L_1 - R_2 \times L_2| < 5$

where R_c is a mean radius (for example, 0.5m) of the current sensing coil, L_c a fiber length (for example, 10m) of the current sensing coil, R_1 a mean radius (for example, 0.035m=35mm) of the counter-clockwise length adjusting optical fiber coil 71, L_1 an optical fiber length (for example, 57m) of the counter-clockwise length adjusting optical fiber coil 71, R_2 a mean radius (for example, 0.035m=35mm) of the clockwise length adjusting optical fiber coil 72, and L_2 an optical fiber length (for example, 200m) of the clockwise length adjusting optical fiber coil 72.

Amend two paragraphs beginning in line 10 on page 21 as follows:

It is recognized that a current sensor using a ~~sagnac~~ Sagnac interferometer as mentioned above is required to be disposed such that an entire current sensor including the current sensing coil 6 be disposed close to an electric wire when detecting a magnetic field which is generated by the ~~currenting~~ current through the electric wire, and this often involves inconveniences and difficulties in its installation and maintenance. Accordingly, an arrangement is chosen in which a current sensor using a ~~sagnac~~ Sagnac interferometer be mechanically divided into a plurality of blocks of optical elements which constitute the sensor and the divided blocks are connected together through optical connectors and optical fibers.

An embodiment of a current sensor using a ~~sagnac~~ Sagnac interferometer which is divided into a plurality of blocks of optical elements is shown in Fig. 7, where corresponding parts to those shown in Fig. 3 are designated by reference characters as used before.

Amend the paragraph beginning in line 18 on page 22 as follows:

The separation and division as mentioned above are enabled as an advantage of using single mode optical fibers to connect between the optical elements. Specifically, the extended optical fiber 20 which connects between the first optical connector 21 and the second optical connector 22 is formed by a single mode optical fiber, and the first optical connector 21 and the second optical connector 22 then can be optical connectors which are used for connection of single mode optical fibers. Where an optical fiber which connects between optical elements is a polarization ~~sustaining~~ maintaining optical fiber, it is necessary as a matter of course that the corresponding optical connectors be those which are used to connect with a polarization ~~sustaining~~ maintaining optical fiber. However, it will be appreciated that optical connectors which are used for connection with a polarization ~~sustaining~~ maintaining optical fiber are much more expensive than optical connectors which are connected with single mode optical fibers. In the present embodiment, inexpensive connectors which are used to connect with single mode optical fibers can be used to connect between the blocks.

Amend the paragraph beginning in line 6 on page 24 as follows:

As discussed above, in accordance with the invention, Sagnac interferometer is used to detect a phase difference between levo- and dextro-rotatory lights occurring in the current sensing coil under the influence of a magnetic field. By disposing a combination of a polarization filter and a quarter-wave plate on each end of the current sensing coil, an irreciprocal phase difference which is produced under the influence of a magnetic field is maximized by propagating the levo- and dextro-rotatory lights as circularly polarized light, thus optimizing the sensitivity to the magnetic field or the current. A mensuration range which is as high as four orders of magnitude greater than the performance in the optical fiber gyro can be readily realized. The use of a combination of a polarization filter and a depolarizer simplifies at least a coupling with the light source, and depending on the manner of arrangement, inexpensive single mode optical fibers can be used for various optical elements and for the connection therebetween, thus allowing a current sensor using

a ~~sagnac~~ Sagnac interferometer to be provided at a low cost. In particular, in a current sensor using a ~~sagnac~~ Sagnac interferometer, when a length adjusting optical fiber coil is connected in series with a first optical path between one branch end of a second optical branch unit and a first quarter-wave plate, and another length adjusting optical fiber coil is connected in series in a second optical path between the other branch end of the second optical branch unit and a second quarter-wave plate, a resulting reduction in the cost required is significant when an expensive single mode optical fiber can be used for this purpose in as much as the length adjusting optical fiber coil has a greatly increased length on the order of ninety meters.

Amend the paragraph beginning in line 26 on page 25 as follows:

As mentioned previously, the current sensing coil 6, the counter-clockwise length adjusting optical fiber coil 71 and the clockwise length adjusting optical fiber coil 72 have a mutual relationship in regard to the phase difference which results from the Sagnac effect, but when the requirement $\cancel{|R_e \times L_e + R_1 \times L_1 - R_2 \times L_2| < 5}$ $\underline{|R_c \times L_c + R_1 \times L_1 - R_2 \times L_2| < 5}$ is satisfied, the phase difference resulting from the Sagnac effect which is caused by the respective rotations of the current sensing coil, the coil in the first optical path and the coil in the second optical path can be reduced.